Looking at the Springtime Troposphere and Lower Stratosphere over the Central North Pacific Through Many Pairs of Glasses: An INTEX-B Case Study using an AURA Validation Science Paradigm

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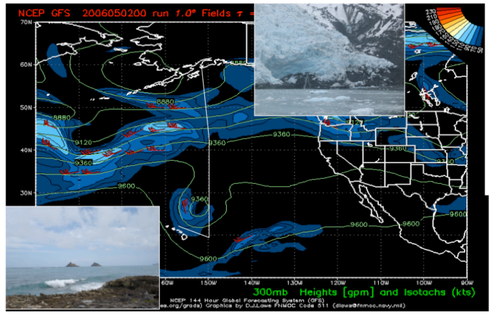
INTRODUCTION:

During the recent Intercontinental Chemical Transport Experiment – Phase B (INTEX-B) aircraft intensive, the NASA DC-8 flew from Oahu, Hawaii to Anchorage, Alaska with the science objectives of characterizing the Central Pacific upper troposphere and lower stratosphere, and of obtaining correlative data for the TES and HIRDLS satellite instruments. The Pacific transect flight took place on May 1, 2006, capturing a picture of the atmosphere during an interesting synoptic-scale flow pattern, ideal for testing our ability to answer tough science questions by combining satellite observations with remote and in situ aircraft data.

The DC-8 flew in the upper troposphere at 240-215 mb during most of the flight, passing from the tropics through a cut-off low, and then crossing the polar jet and into the stratospheric "middle world". TES satellite observations provide the big picture of Central Pacific ozone (O3) distributions in a larger global context. Two ozone lidars operating on the DC-8 reveal both filamentation and wave structure in troposphere and lower stratosphere that is associated with the major dynamical features. In situ air sampling reveals pollution layers in both the upper troposphere and the middle world, and small filaments of stratospheric air mixed in to the upper troposphere near the cutoff low. This case provides a context for exploring how different measurements see sharp horizontal and vertical ozone gradients, how inhomogeneity might be observed at differing spatial scales, and by looking at a specific case study addresses the more general question of how very different data sets can be combined to characterize multi-scale processes, such as the exchange of air between stratosphere and troposphere.

NCEP 300 hPa Heights and Winds

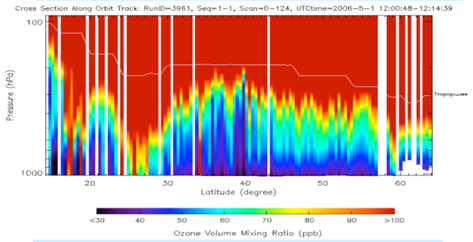
The DC-8 flew from Honolulu, Hawaii, to Anchorage, Alaska, near longitude 150 W.



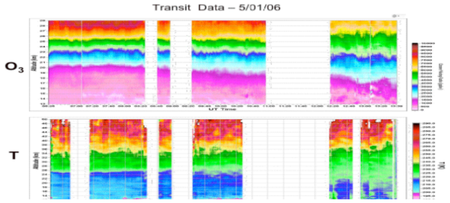
Note the Cut-off Low at about 28N, 152W and the Polar Jet Streak at 45N, 160W.

Cross-Section: The View From Above and the View from Below:

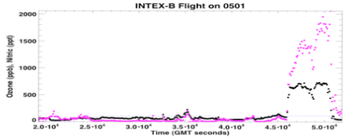
TES Step & Stare Ozone Curtain



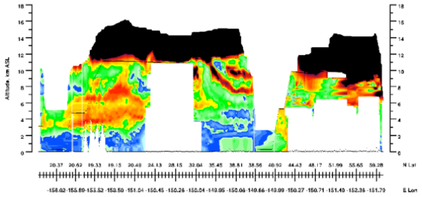
AROTAL Ozone and Temp. Flight Curtains



In Situ Ozone (black) and HNO3 (magenta)

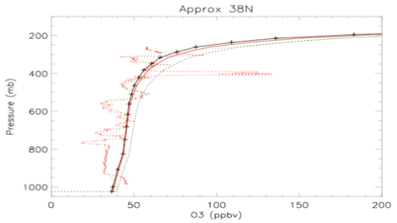


Dial Flight Curtain with Interpolation to FASTOZ at Flight Level

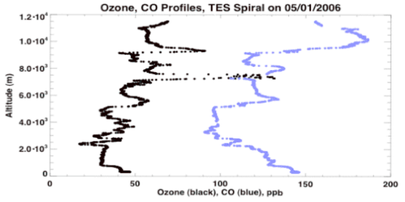


Several Views of the Same Midlatitude Central Pacific Profile:

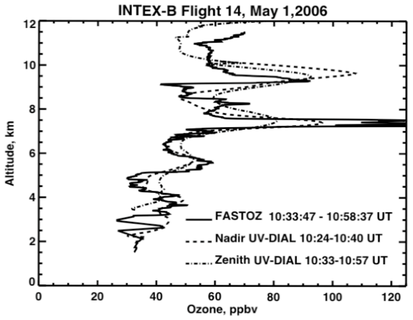
TES Ozone Profile with In Situ



In Situ Ozone (black) and CO (blue)

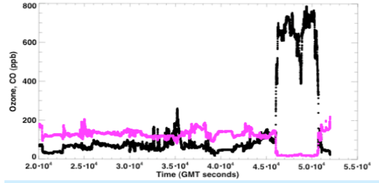


DIAL Nadir and Zenith Ozone Profiles with In Situ

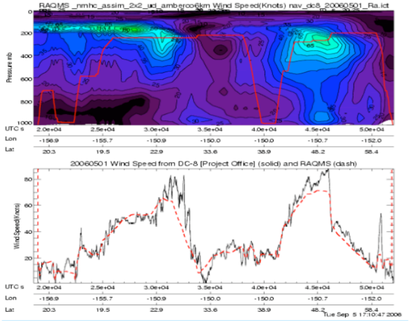


The Upper Troposphere and Lower Stratosphere are Inhomogenious Due to Both Pollution Plumes and Strat/Trop Exchange Processes

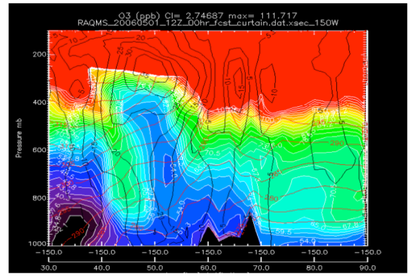
In Situ Ozone (black) and CO (magenta)



GFS Wind Field (from RAQMS)



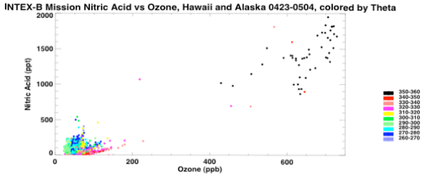
RAQMS Modeled Ozone Flight Curtain with Theta (red) and Winds (black



Tracer Correlations - Clues to Stratospheric Tropospheric Mixing Processes:

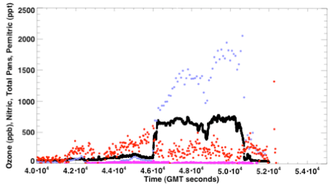
In Situ Nitric Acid vs Ozone Correlations

Points with O3 > 200 ppb were measured May 1



In Situ Ozone (black), Nitric Acid (blue), Pernitric Acid (magenta), Total PANS (red)

Preliminary data - Is there a significant amount of PAN Pollution in the Stratospheric Middle World?



AURA Validation Science Questions:

- How much of the ozone we observe in the Upper Troposphere/ Lower Stratosphere is produced/destroyed by photochemistry (anthropogenic component) or transferred by STE (natural)?
- What is the horizontal and vertical variability of ozone in the lower stratosphere, tropopause, and upper troposphere?
- What is the impact of small-scale processes on inhomogeneity and ozone distributions diagnosed from lower resolution models and satellite instruments?
- Because they are both accurate and precise, in situ measurements are critical to validation of aircraft and satellite instrumentation for remote sensing.